APPENDIX II

FORMAC Source Program Generating the Equations of Motion of the Seven Element Stick Man

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INPUT TO FORMAC PREPROCESSOR
  DERIP: PROCEDURE OPTIONS(MAIN);
  FORMAC_OPTIONS;
     LET(VTRSO=DX*UX+DY*UY);
     LET(VHSOA=LTRM*DTHTA*UTHTA+VTRSO);
     LET(VHSB=EVAL(VHSOA,UX,UTR*SIN(THETA)-UTHTA*COS(THETA)));
     LET(VHSO=EVAL(VHSB,UY,UTR*COS(THETA)+UTHTA*SIN(THETA)));
  ATOMIZE(VHSB);
     LET(VTHSOA=LTHM*DGAMA*UGAMA+VHSO);
     LET(VTHSA=EVAL(VTHSOA,UTHTA,-UTH*SIN(GAMMA)-UGAMA*COS(GAMMA)));
     LET(VTHSO=EVAL(VTHSA,UTR,-UTH*COS(GAMMA)+UGAMA*SIN(GAMMA)));
  ATOMIZE(VTHSA);
     LET(VKSO=EVAL(VTHSO,LTHM,LTH));
     LET(VSHSOA=LSHM*DBETA*UBETA+VKSO);
     LET(VSHSA=EVAL(VSHSOA,UTH,USH*COS(BETA)-UBETA*SIN(BETA)));
     LET(VSHSO=EVAL(VSHSA,UGAMA,-UBETA*COS(BETA)-USH*SIN(BETA)));
  ATOMIZE(VSHSA);
     LET(VASO=EVAL(VSHSO,LSHM,LSH));
     LET(VFTSOA=LFTM*DALFA*UALFA+VASO);
     LET(VFTSA=EVAL(VFTSOA,USH,UALFA*COS(ALPHA)+UFT*SIN(ALPHA)));
     LET(VFTSO=EVAL(VFTSA,UBETA,-UFT*COS(ALPHA)+UALFA*SIN(ALPHA)));
  ATOMIZE(VFTSA);
     LET(VSSOA=-(LTR-LTRM)*DTHTA*UTHTA+VTRSO);
     LET(VSSA=EVAL(VSSOA,UX,UTR*SIN(THETA)-UTHTA*COS(THETA)));
     LET(VSSO=EVAL(VSSA,UY,UTR*COS(THETA)+UTHTA*SIN(THETA)));
  ATOMIZE(VSSA);
     LET(VUASOA=LUAM*DDLTA*UDLTA+VSSO);
     LET(VUASA=EVAL(VUASOA,UTHTA,-UDLTA*COS(DELTA)-UUA*SIN(DELTA)));
     LET(VUASO=EVAL(VUASA,UTR,UDLTA*SIN(DELTA)-UUA*COS(DELTA)));
  ATOMIZE(VUASA);
     LET(VESO=EVAL(VUASO,LUAM,LUA));
     LET(VFASOA=LFAM*DEPSN*UEPSN+VESO);
     LET(VFASA=EVAL(VFASOA,UDLTA,UEPSN*COS(EPSN)+UFA*SIN(EPSN)));
     LET(VFASO=EVAL(VFASA,UUA,-UEPSN*SIN(EPSN)+UFA*COS(EPSN)));
  ATOMIZE(VFASA);
     LET(VHDSOA=LHDM*DZETA*UZETA+VSSO);
     LET(VHDSA=EVAL(VHDSOA,UTR,UHD*COS(ZETA)-UZETA*SIN(ZETA)));
     LET(VHDSO=EVAL(VHDSA,UTHTA,-UHD*SIN(ZETA)-UZETA*COS(ZETA)));
  ATOMIZE(VHDSA);
    OPTSET(EXPND);
     LET(T1R=(1/2)*JTR*DTHTA**2+(1/2)*MTR*(COEFF(VTRSO,UX)**2));
     LET(TTR=T1R+(1/2)*MTR*(COEFF(VTRSO,UY)**2));
  ATOMIZE(T1R);
     ATOMIZE(VTRSO;VHSOA;VHSO);
     LET(TTR1=DERIV(TTR,X));
     LET(TTR2=DERIV(TTR,Y));
     LET(TTR3=DERIV(TTR,THETA));
     LET(TTR4=DERIV(TTR,GAMMA));
     LET(TTR5=DERIV(TTR,BETA));
     LET(TTR6=DERIV(TTR,DELTA));
     LET(TTR7=DERIV(TTR,ALPHA));
     LET(TTR8=DERIV(TTR,EPSN));
     LET(TTR9=DERIV(TTR,ZETA));
     LET(TTR10=DERIV(TTR,DX));
     LET(TTR11=DERIV(TTR,DY));
     LET(TTR12=DERIV(TTR,DTHTA));
     LET(TTR13=DERIV(TTR,DGAMA));
     LET(TTR14=DERIV(TTR,DBETA));
     LET(TTR15=DERIV(TTR,DDLTA));
     LET(TTR16=DERIV(TTR,DALFA));
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      LET(TTR17=DERIV(TTR,DEPSN));
      LET(TTR18=DERIV(TTR,DZETA));
     LET(TTR10A=REPLACE(TTR10,DX,DX.(T)));
     LET(TTR11A=REPLACE(TTR11,DY,DY.(T)));
     LET(TTR12A=REPLACE(TTR12,DTHTA,DTHTA.(T)));
      LET(TTR19=DERIV(TTR10A,T));
     LET(TTR20=DERIV(TTR11A,T));
     LET(TTR21=DERIV(TTR12A,T));
  ATOMIZE(TTR10A;TTR11A;TTR12A);
  ATOMIZE(TTR19;TTR20;TTR21);
  ATOMIZE(TTR;TTR1;TTR2;TTR3;TTR4;TTR5;TTR6;TTR7;TTR8;TTR9);
  ATOMIZE(TTR10;TTR11;TTR12;TTR13;TTR14;TTR15;TTR16;TTR17;TTR18);
 LET(T1H=(1/2)*JTH*(DTHTA-DGAMA)**2+(1/2)*MTH*(COEFF(VTHSO,UTH)**2));
      LET(TTH=T1H+(1/2)*NTH*(COEFF(VTHSO,UGAMA)**2));
      ATOMIZE(VTHSO;VTHSOA);
  ATOMIZE(T1H);
      LET(TTH1=DERIV(TTH,X));
      LET(TTH2=DERIV(TTH,Y));
      LET(TTH3=DERIV(TTH,THETA));
      LET(TTH4=DERIV(TTH,GAMMA));
      LET(TTH5=DERIV(TTH,BETA));
      LET(TTH6=DERIV(TTH,DELTA));
      LET(TTH7=DERIV(TTH,ALPHA));
      LET(TTH8=DERIV(TTH,EPSN));
      LET(TTH9=DERIV(TTH,ZETA));
      LET(TTH10=DERIV(TTH,DX));
      LET(TTH10A=REPLACE(TTH10,GAMMA,GAMMA.(T),THETA,THETA.(T)));
 LET(TTH10A=REPLACE(TTH10A,DGAMA,DGAMA.(T),DX,DX.(T),DTHTA,DTHTA.(T)));
      ATOMIZE(TTH10);
      LET(TTH11=DERIV(TTH,DY));
 LET(TTH11A=REPLACE(TTH11,GAMMA,GAMMA.(T),THETA,THETA.(T)));
 LET(TTH11A=REPLACE(TTH11A,DGAMA,DGAMA.(T),DY,DY.(T),DTHTA,DTHTA.(T)));
      ATOMIZE(TTH11);
      LET(TTH12=DERIV(TTH,DTHTA));
 LET(TTH12A=REPLACE(TTH12,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T)));
 LET(TTH12A=REPLACE(TTH12A,GAMMA,GAMMA.(T),THETA,THETA.(T)));
 LET(TTH12A=REPLACE(TTH12A,DX,DX.(T),DY,DY.(T)));
      ATOMIZE(TTH12);
      LET(TTH13=DERIV(TTH,DGAMA));
 LET(TTH13A=REPLACE(TTH13,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
 LET(TTH13A=REPLACE(TTH13A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
      ATOMIZE(TTH13);
      LET(TTH14=DERIV(TTH,DBETA));
      LET(TTH15=DERIV(TTH,DDLTA));
      LET(TTH16=DERIV(TTH,DALPA));
      LET(TTH17=DERIV(TTH,DEPSN));
      LET(TTH18=DERIV(TTH,DZETA));
      LET(TTH19=DERIV(TTH10A,T));
      LET(TTH20=DERIV(TTH11A,T));
      LET(TTH21=DERIV(TTH12A,T));
      LET(TTH22=DERIV(TTH13A,T));
      ATOMIZE(TTH19;TTH20;TTH21;TTH22;TTH23);
  ATOMIZE(TTH;TTH1;TTH2;TTH3;TTH4;TTH5;TTH6;TTH7;TTH8;TTH9);
  ATOMIZE(TTH10;TTH11;TTH12;TTH13;TTH14;TTH15;TTH16;TTH17;TTH18);
      LET(T5H=(1/2)*JSH*(DTHTA-DGAMA+DBETA)**2);
      LET(T6H=(1/2)*MSH*(COEFF(VSHSO,USH)**2));
      LET(TSH=T5H+T6H+(1/2)*MSH*(COEFF(VSHSO,UBETA)**2));
  ATOMIZE(T5H;T6H);
      ATOMIZE(VSHSO;VKSO;VSHSOA);
      LET(TSH1=DERIV(TSH,X));
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      LET(TSH2=DERIV(TSH,Y));
      LET(TSH3=DERIV(TSH,THETA));
      LET(TSH4=DERIV(TSH,GAMMA));
      LET(TSH5=DERIV(TSH,BETA));
      LET(TSH6=DERIV(TSH,DELTA));
      LET(TSH7=DERIV(TSH,ALPHA));
      LET(TSH8=DERIV(TSH,EPSN));
      LET(TSH9=DERIV(TSH,ZETA));
      LET(TSH10=DERIV(TSH,DX));
  LET(TSH10A=REPLACE(TSH10,GAMMA,GAMMA.(T),THETA,THETA.(T)));
  LET(TSH10A=REPLACE(TSH10A,BETA,BETA.(T),DGAMA,DGAMA.(T)));
  LET(TSH10A=REPLACE(TSH10A,DBETA,DBETA.(T),DX,DX.(T),DTHTA,DTHTA.(T)));
      ATOMIZE(TSH10);
      LET(TSH11=DERIV(TSH,DY));
  LET(TSH11A=REPLACE(TSH11,GAMMA,GAMMA.(T),THETA,THETA.(T)));
  LET(TSH11A=REPLACE(TSH11A,BETA,BETA.(T),DGAMA,DGAMA.(T)));
  LET(TSH11A=REPLACE(TSH11A,DBETA,DBETA.(T),DY,DY.(T),DTHTA,DTHTA.(T)));
      ATOMIZE(TSH11);
      LET(TSH12=DERIV(TSH,DTHTA));
  LET(TSH12A=REPLACE(TSH12,GAMMA,GAMMA.(T),BETA,BETA.(T)));
  LET(TSH12A=REPLACE(TSH12A,DGAMA,DGAMA.(T),DBETA,DBETA.(T),DX,DX.(T)));
  LET(TSH12A=REPLACE(TSH12A,THETA,THETA.(T),DY,DY.(T),DTHTA,DTHTA.(T)));
      ATOMIZE(TSH12);
      LET(TSH13=DERIV(TSH,DGAMA));
  LET(TSH13A=REPLACE(TSH13,BETA,BETA.(T),DBETA,DBETA.(T),DX,DX.(T)));
  LET(TSH13A=REPLACE(TSH13A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
  LET(TSH13A=REPLACE(TSH13A,DTHTA,DTHTA.(T),DGAMA,DGAMA.(T)));
     ATOMIZE(TSH13);
      LET(TSH14=DERIV(TSH,DBETA));
  LET(TSH14A=REPLACE(TSH14,BETA,BETA.(T),DGAMA,DGAMA.(T),DX,DX.(T)));
  LET(TSH14A=REPLACE(TSH14A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
  LET(TSH14A=REPLACE(TSH14A,DTHTA,DTHTA.(T),DBETA,DBETA.(T)));
      ATOMIZE(TSH14);
      LET(TSH15=DERIV(TSH,DDLTA));
      LET(TSH16=DERIV(TSH,DALFA));
      LET(TSH17=DERIV(TSH,DEPSN));
      LET(TSH18=DERIV(TSH,DZETA));
      LET(TSH19=DERIV(TSH10A,T));
      LET(TSH20=DERIV(TSH11A,T));
      LET(TSH21=DERIV(TSH12A,T));
      LET(TSH22=DERIV(TSH13A,T));
      LET(TSH23=DERIV(TSH14A,T));
      ATOMIZE(TSH19;TSH20;TSH21;TSH22;TSH23);
  ATOMIZE(TSH;TSH1;TSH2;TSH3;TSH4;TSH5;TSH6;TSH7;TSH8;TSH9);
  ATOMIZE(TSH10;TSH11;TSH12;TSH13;TSH14;TSH15;TSH16;TSH17;TSH18);
  OPTSET(LINELENGTH=72); OPTSET(PRINT);
      LET(T1T=(1/2)*JFT*(DTHTA-DGAMA+DBETA+DALFA)**2);
      LET(T2T=(1/2)*MFT*(COEFF(VFTSO,DALFA)**2));
      LET(TFT=T1T+T2T+(1/2)*MFT*(COEFF(VFTSO,UFT)**2));
      ATOMIZE(VFTSO;VFTSOA;VASO);
  ATOMIZE(T1T;T2T);
      LET(TFT1=DERIV(TFT,X));
      LET(TFT2=DERIV(TFT,Y));
      LET(TFT3=DERIV(TFT,THETA));
      LET(TFT4=DERIV(TFT,GAMMA));
      LET(TFT5=DERIV(TFT,BETA));
      LET(TFT6=DERIV(TFT,DELTA));
      LET(TFT7=DERIV(TFT,ALPHA));
      LET(TFT8=DERIV(TFT,EPSN));
      LET(TFT9=DERIV(TFT,ZETA));
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      LET(TFT10=DERIV(TFT,DX));
  LET(TFT10A=REPLACE(TFT10,GAMMA,GAMMA.(T),THETA,THETA.(T)));
     ATOMIZE(TFT10);
  LET(TFT10A=REPLACE(TFT10A,BETA,BETA.(T),ALPHA,ALPHA.(T)));
  LET(TFT10A=REPLACE(TFT10A,DBETA,DBETA.(T),DALFA,DALFA.(T)));
  LET(TFT10A=REPLACE(TFT10A,DGAMA,DGAMA.(T),DY,DX.(T),DTHTA,DTHTA.(T)));
      LET(TFT11=DERIV(TFT,DY));
  LET(TFT11A=REPLACE(TFT11,GAMMA,GAMMA.(T),THETA,THETA.(T)));
     ATOMIZE(TFT11);
  LET(TFT11A=REPLACE(TFT11A,BETA,BETA.(T),ALPHA,ALPHA.(T)));
  LET(TFT11A=REPLACE(TFT11A,DBETA,DBETA.(T),DALFA,DALFA.(T)));
  LET(TFT11A=REPLACE(TFT11A,DGAMA,DGAMA.(T),DY,DY.(T),DTHTA,DTHTA.(T)));
      LET(TFT12=DERIV(TFT,DTHTA));
  LET(TFT12A=REPLACE(TFT12,DALFA,DALFA.(T),DBETA,DBETA.(T)));
     ATOMIZE(TFT12);
  LET(TFT12A=REPLACE(TFT12A,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T)));
  LET(TFT12A=REPLACE(TFT12A,GAMMA,GAMMA.(T),BETA,BETA.(T),DX,DX.(T)));
  LET(TFT12A=REPLACE(TFT12A,ALPHA,ALPHA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TFT13=DERIV(TFT,DGAMA));
  LET(TFT13A=REPLACE(TFT13,DALFA,DALFA.(T),DBETA,DBETA.(T)));
     ATOMIZE(TFT13);
  LET(TFT13A=REPLACE(TFT13A,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T)));
  LET(TFT13A=REPLACE(TFT13A,BETA,BETA.(T),ALPHA,ALPHA.(T),DX,DX.(T)));
  LET(TFT13A=REPLACE(TFT13A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TFT14=DERIV(TFT,DBETA));
  LET(TFT14A=REPLACE(TFT14,DALFA,DALFA.(T),DBETA,DBETA.(T)));
     ATOMIZE(TFT14);
  LET(TFT14A=REPLACE(TFT14A,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T)));
  LET(TFT14A=REPLACE(TFT14A,ALPHA,ALPHA.(T),BETA,BETA.(T),DX,DX.(T)));
  LET(TFT14A=REPLACE(TFT14A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TFT15=DERIV(TFT,DDLTA));
      LET(TFT16=DERIV(TFT,DALFA));
  LET(TFT16A=REPLACE(TFT16,DALFA,DALFA.(T),DBETA,DBETA.(T)));
     ATOMIZE(TFT16);
  LET(TFT16A=REPLACE(TFT16A,DGAMA,DGAMA.(T),DTHTA,DTHTA.(T)));
  LET(TFT16A=REPLACE(TFT16A,ALPHA,ALPHA.(T),BETA,BETA.(T),DX,DX.(T)));
  LET(TFT16A=REPLACE(TFT16A,GAMMA,GAMMA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TFT17=DERIV(TFT,DEPSN));
      LET(TFT18=DERIV(TFT,DZETA));
      LET(TFT19=DERIV(TFT10A,T));
      LET(TFT20=DERIV(TFT11A,T));
      LET(TFT21=DERIV(TFT12A,T));
      LET(TFT22=DERIV(TFT13A,T));
      LET(TFT23=DERIV(TFT14A,T));
      LET(TFT25=DERIV(TFT16A,T));
     ATOMIZE(TFT19;TFT20;TFT21;TFT22;TFT23;TFT25);
   ATOMIZE(TFT;TFT1;TFT2;TFT3;TFT4;TFT5;TFT6;TFT7;TFT8;TFT9);
   ATOMIZE(TFT10;TFT11;TFT12;TFT13;TFT14;TFT15;TFT16;TFT17;TFT18);
      LET(T1A=(1/2)*JUA*(DTHTA-DDLTA)**2);
      LET(T2A=(1/2)*MUA*(COEFF(VUASO,UDLTA)**2));
      LET(TUA=T1A+T2A+(1/2)*MUA*(COEFF(VUASO,UUA)**2));
      ATOMIZE(VUASO;VUASOA);
   ATOMIZE(T1A;T2A);
      LET(TUA1=DERIV(TUA,X));
      LET(TUA2=DERIV(TUA,Y));
      LET(TUA3=DERIV(TUA,THETA));
      LET(TUA4=DERIV(TUA,GAMMA));
      LET(TUA5=DERIV(TUA,BETA));
      LET(TUA6=DERIV(TUA,DELTA));
      LET(TUA7=DERIV(TUA,ALPHA));
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      LET(TUA8=DERIV(TUA,EPSN));
      LET(TUA9=DERIV(TUA,ZETA));
      LET(TUA10=DERIV(TUA,DX));
  LET(TUA10A=REPLACE(TUA10,THETA,THETA.(T),DELTA,DELTA.(T)));
     ATOMIZE(TUA10);
  LET(TUA10A=REPLACE(TUA10A,DTHTA,DTHTA.(T),DDLTA,DDLTA.(T)));
  LET(TUA10A=REPLACE(TUA10A,DX,DX.(T),DTHTA,DTHTA.(T)));
      LET(TUA11=DERIV(TUA,DY));
  LET(TUA11A=REPLACE(TUA11,THETA,THETA.(T),DELTA,DELTA.(T)));
     ATOMIZE(TUA11);
  LET(TUA11A=REPLACE(TUA11A,DTHTA,DTHTA.(T),DDLTA,DDLTA.(T),DY,DY.(T)));
      LET(TUA12=DERIV(TUA,DTHTA));
  LET(TUA12A=REPLACE(TUA12,DDLTA,DDLTA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
     ATOMIZE(TUA12);
  LET(TUA12A=REPLACE(TUA12A,DELTA,DELTA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TUA13=DERIV(TUA,DGAMA));
      LET(TUA14=DERIV(TUA,DBETA));
      LET(TUA15=DERIV(TUA,DDLTA));
  LET(TUA15A=REPLACE(TUA15,DDLTA,DDLTA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
     ATOMIZE(TUA15);
  LET(TUA15A=REPLACE(TUA15A,DELTA,DELTA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TUA16=DERIV(TUA,DALFA));
      LET(TUA17=DERIV(TUA,DEPSN));
      LET(TUA18=DERIV(TUA,DZETA));
      LET(TUA19=DERIV(TUA10A,T));
      LET(TUA20=DERIV(TUA11A,T));
      LET(TUA21=DERIV(TUA12A,T));
      LET(TUA24=DERIV(TUA15A,T));
     ATOMIZE(TUA19;TUA20;TUA21;TUA24);
   ATOMIZE(TUA;TUA1;TUA2;TUA3;TUA4;TUA5;TUA6;TUA7;TUA8;TUA9);
   ATOMIZE(TUA10;TUA11;TUA12;TUA13;TUA14;TUA15;TUA16;TUA17;TUA18);
      LET(T5A=(1/2)*JFA*(DTHTA-DDLTA-DEPSN)**2);
      LET(T6A=(1/2)*MFA*(COEFF(VFASO,UEPSN)**2));
      LET(TFA=T5A+T6A+(1/2)*MFA*(COEFF(VFASO,UFA)**2));
     ATOMIZE(VFASO;VFASOA;VESO);
   ATOMIZE(T5A;T6A);
      LET(TFA1=DERIV(TFA,X));
      LET(TFA2=DERIV(TFA,Y));
      LET(TFA3=DERIV(TFA,THETA));
      LET(TFA4=DERIV(TFA,GAMMA));
      LET(TFA5=DERIV(TFA,BETA));
      LET(TFA6=DERIV(TFA,DELTA));
      LET(TFA7=DERIV(TFA,ALPHA));
      LET(TFA8=DERIV(TFA,EPSN));
      LET(TFA9=DERIV(TFA,ZETA));
      LET(TFA10=DERIV(TFA,DX));
  LET(TFA10A=REPLACE(TFA10,THETA,THETA.(T),DELTA,DELTA.(T)));
     ATOMIZE(TFA10);
  LET(TFA10A=REPLACE(TFA10A,EPSN,EPSN.(T),DDLTA,DDLTA.(T),DX,DX.(T)));
  LET(TFA10A=REPLACE(TFA10A,DEPSN,DEPSN.(T),DTHTA,DTHTA.(T)));
      LET(TFA11=DERIV(TFA,DY));
  LET(TFA11A=REPLACE(TFA11,THETA,THETA.(T),DELTA,DELTA.(T)));
     ATOMIZE(TFA11);
  LET(TFA11A=REPLACE(TFA11A,EPSN,EPSN.(T),DDLTA,DDLTA.(T),DY,DY.(T)));
  LET(TFA11A=REPLACE(TFA11A,DEPSN,DEPSN.(T),DTHTA,DTHTA.(T)));
      LET(TFA12=DERIV(TFA,DTHTA));
  LET(TFA12A=REPLACE(TFA12,DEPSN,DEPSN.(T),DDLTA,DDLTA.(T)));
      ATOMIZE(TFA12);
  LET(TFA12A=REPLACE(TFA12A,DTHTA,DTHTA.(T),DELTA,DELTA.(T),DX,DX.(T)));
  LET(TFA12A=REPLACE(TFA12A,EPSN,EPSN.(T),THETA,THETA.(T),DY,DY.(T)));
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      LET(TFA13=DERIV(TFA,DGAMA));
      LET(TFA14=DERIV(TFA,DBETA));
      LET(TFA15=DERIV(TFA,DDLTA));
  LET(TFA15A=REPLACE(TFA15,DEPSN,DEPSN.(T),DDLTA,DDLTA.(T)));
     ATOMIZE(TFA15);
  LET(TFA15A=REPLACE(TFA15A,DTHTA,DTHTA.(T),EPSN,EPSN.(T),DX,DX.(T)));
  LET(TFA15A=REPLACE(TFA15A,DEPSN,DEPSN.(T),DELTA,DELTA.(T)));
  LET(TFA15A=REPLACE(TFA15A,THETA,THETA.(T),DY,DY.(T)));
      LET(TFA16=DERIV(TFA,DALFA));
      LET(TFA17=DERIV(TFA,DEPSN));
  LET(TFA17A=REPLACE(TFA17,DEPSN,DEPSN.(T),DDLTA,DDLTA.(T)));
     ATOMIZE(TFA17);
  LET(TFA17A=REPLACE(TFA17A,DTHTA,DTHTA.(T),EPSN,EPSN.(T),DX,DX.(T)));
  LET(TFA17A=REPLACE(TFA17A,DELTA,DELTA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(TFA18=DERIV(TFA,DZETA));
      LET(TFA19=DERIV(TFA10A,T));
      LET(TFA20=DERIV(TFA11A,T));
      LET(TFA21=DERIV(TFA12A,T));
      LET(TFA24=DERIV(TFA15A,T));
      LET(TFA26=DERIV(TFA17A,T));
     ATOMIZE(TFA19;TFA20;TFA21;TFA24;TFA26);
   ATOMIZE(TFA;TFA1;TFA2;TFA3;TFA4;TFA5;TFA6;TFA7;TFA8;TFA9);
   ATOMIZE(TFA10;TFA11;TFA12;TFA13;TFA14;TFA15;TFA16;TFA17;TFA18);
      LET(T1D=(1/2)*JHD*(DTHTA+DZETA)**2);
      LET(T2D=(1/2)*MHD*(COEFF(VHDSO,UHD)**2));
      LET(THD=T1D+T2D+(1/2)*MHD*(COEFF(VHDSO,UZETA)**2));
      ATOMIZE(VHDSO;VHDSOA);
   ATOMIZE(T1D;T2D);
      LET(THD1=DERIV(THD,X));
      LET(THD2=DERIV(THD,Y));
      LET(THD3=DERIV(THD,THETA));
      LET(THD4=DERIV(THD,GAMMA));
      LET(THD5=DERIV(THD,BETA));
      LET(THD6=DERIV(THD,DELTA));
      LET(THD7=DERIV(THD,ALPHA));
      LET(THD8=DERIV(THD,EPSN));
      LET(THD9=DERIV(THD,ZETA));
      LET(THD10=DERIV(THD,DX));
  LET(THD10A=REPLACE(THD10,THETA,THETA.(T),ZETA,ZETA.(T)));
     ATOMIZE(THD10);
  LET(THD10A=REPLACE(THD10A,DZETA,DZETA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
      LET(THD11=DERIV(THD,DY));
  LET(THD11A=REPLACE(THD11,THETA,THETA.(T),ZETA,ZETA.(T)));
     ATOMIZE(THD11);
  LET(THD11A=REPLACE(THD11A,DZETA,DZETA.(T),DTHTA,DTHTA.(T),DY,DY.(T)));
      LET(THD12=DERIV(THD,DTHTA));
  LET(THD12A=REPLACE(THD12,DZETA,DZETA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
     ATOMIZE(THD12);
  LET(THD12A=REPLACE(THD12A,ZETA,ZETA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(THD13=DERIV(THD,DGAMA));
      LET(THD14=DERIV(THD,DBETA));
      LET(THD15=DERIV(THD,DDLTA));
      LET(THD16=DERIV(THD,DALFA));
      LET(THD17=DERIV(THD,DEPSN));
      LET(THD18=DERIV(THD,DZETA));
  LET(THD18A=REPLACE(THD18,DZETA,DZETA.(T),DTHTA,DTHTA.(T),DX,DX.(T)));
     ATOMIZE(THD18);
  LET(THD18A=REPLACE(THD18A,ZETA,ZETA.(T),THETA,THETA.(T),DY,DY.(T)));
      LET(THD19=DERIV(THD10A,T));
      LET(THD20=DERIV(THD11A,T));
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      LET(THD21=DERIV(THD12A,T));
      LET(THD27=DERIV(THD18A,T));
    ATOMIZE(THD19;THD20;THD21;THD22);
  ATOMIZE(THD;THD1;THD2;THD3;THD4;THD5;THD6;THD7;THD8;THD9);
  ATOMIZE(THD10;THD11;THD12;THD13;THD14;THD15;THD16;THD17;THD18);
  OPTSET(NOPRINT);
  OPTSET(EXPND);
  END DERIP;
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